REMARKS/ARGUMENTS

Favorable reconsideration of this application as currently amended and in light of the following discussion is respectfully requested.

Claims 1-34 are currently pending. The present Amendment amends Claims 1-3, 5-8, 13, 15, 17, 18, 20-23, and 27; and adds Claims 29-34. The changes and additions to the claims are supported by the originally filed application. No new matter has been added.

In the outstanding Office Action, Claims 1, 3-11, 13-16, 18-25, and 27 were rejected under 35 U.S.C. § 102(b) as being anticipated by Chiu et al. (U.S. Patent No. 5,369,678, herein "Chiu"); Claims 12 and 26 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Chiu; Claims 2 and 17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Chiu in view of Ohishi (U.S. Patent No. 6,845,142); and Claim 28 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Chiu in view of Stein (U.S. Patent No. 5,040,199).

Applicant respectfully requests reconsideration of the rejection of Claims 1, 3-11, 13-16, 18-25, and 27 under 35 U.S.C. § 102(b) for the reasons set forth below.

Claim 1 is directed to an X-ray diagnosis apparatus for obtaining an X-ray image, including: (1) an X-ray radiator configured to radiate an X-ray to a specimen; (2) a detector configured to detect an X-ray data resulting from the X-ray; (3) a first shifter mechanism coupled to the detector and configured to shift the detector along a detecting plane of the detector; (4) a changer mechanism coupled to the X-ray radiator and configured to change a radiation direction of the X-ray against the detector; (5) a controller configured to control the changer mechanism in accordance with the shift of the detector; and (6) an image processor coupled to the detector and comprising a first fluoroscopic image data processing portion that prepares the X-ray image based on the detected X-ray data and a second fluoroscopic image data processing portion that corrects a deformation of the fluoroscopic image data.

The Office Action states that "phrases such as 'configured to' are functional in nature and do not convey structural limitations." However, M.P.E.P. § 2143.03 states that "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." It is respectfully submitted that the words used in the claims to state the functionality of recited structures must be considered and given weight in the analysis of patentability. Claim 1 has been amended to emphasize structure, it being noted that the phrase "configured to" is used to cover the invention in its non-operational state, e.g., at a point of sale or while the invention is being shipped. It is further respectfully submitted that words used in a "configured to" sentence are routinely being considered in judging patentability. To that effect, Appendix 1 shows that at least 130 issued patents whose claims recite "configured to ..." language can be found in the USPTO database, even upon limiting the search to Examiners having the surname "Church." In addition, Appendix 2 shows the claims of U.S. Patent No. 6,917,665 in which almost all the features are claimed using "configured to ..." language.

The Office Action asserts at page 2 that Chiu teaches "an angiographic x-ray system for tracking the movement of the catheter tip comprising x-ray source 14,[1] collimator 20, collimator position control 46 (lines 40-47 of column 16), patient support 12, digital imager 3, image chain support and moving means 7 (C-arm, lines 55-63 of column 13), image processor 11/13 with disk storage for determining catheter location and moving the chain in response thereto and display 15." However, Applicant respectfully submits that these teachings do not meet the entirety of the claimed features.

First, Chiu does not teach or suggest "a first shifter mechanism ***coupled to the detector and configured to shift the detector along a detecting plane of the detector***." As illustrated in Figs. 1 and 8 of Chiu, the fluoroscopic image intensifier assembly 12 asserted in

[1] The Office Action indicates "x-ray source **12**," but Applicant believes "x-ray source **14**" was intended to be written.

the Office Action to be analogous to the claimed detector supports the patient and is thus fixed. A person of ordinary skill in the art would understand that it is important that the patient be still and thus that the fluoroscopic image intensifier assembly 12 is fixed while the X-ray source is positioned above an area of interest and operated. The person of ordinary skill in the art might understand that Chiu's source is shifted over the patient, but not its detector which is also the patient's support. There is thus no teaching or suggestion of "a first shifter mechanism ***coupled to the detector and configured to shift the detector along a detecting plane of the detector***," as recited in amended independent Claim 1 in Chiu.

Second, Chiu does not teach or suggest "a changer mechanism ***coupled to the X-ray radiator and configured to change a radiation direction of the X-ray against the detector***." As mentioned above, the Office Action cited column 16, lines 40-47, of Chiu and the collimator position control 46 in this regard. However, whereas the cited passage states that "[c]ommand signals are then derived for moving the center of the collimator hole to the tip," Applicant respectfully submits that this teaches moving the collimator to change a ***location*** of the collimator, but not a change in ***direction*** of the X-ray against the detector. For instance, the coordinates of the collimator may change, but the direction remains a perpendicular one, as illustrated in Chiu's Fig. 8. Applicant points out the non-limiting examples of Figs. 4A, 4B, 11A, and 11B of Applicant's specification as clarifying the distinction between location and direction, and establishing that Chiu does not meet changing the ***direction***. That is, Chiu changes the location of the collimator over the detector, but not the direction of the X-ray against the detector; Applicant's Figs. 4A and 4B change the direction, but not necessarily the location; and Applicant's Fig. 11B shows a situation in which both location and direction are changed with respect to Fig. 11A. There is thus no teaching or suggestion of "a changer mechanism ***coupled to the X-ray radiator and configured to change a radiation direction of the X-ray against the detector***," as recited in amended independent Claim 1 in Chiu.

Third, Chiu does not teach or suggest "a second fluoroscopic image data processing section that corrects a ***deformation*** of the fluoroscopic image data." Chiu "corrects images" in element 33 of Fig. 7, however, Chiu explains its correction by stating that "variations in the intensity of the viewed image make the overall image difficult to read" and "[t]o solve this problem, the pixels in the transitional region 32 and the peripheral region 34 are corrected to match the intensity of the center region 30" so that "[b]y correcting these regions, a uniform overall grey-level is maintained across the view image which results in a more readily comprehensible image."[2] However, correcting intensities to maintain a uniform grey-level in the image is a process unrelated to the correction of a deformation. Further, a deformation, such as in the non-limiting examples of Figs. 11B and 12 of Applicant's specification, does not fit in the context of Chiu since (1) Chiu's detector is not shifted while the source is fixed so that Chiu has no deformation to begin with and (2) Chiu's X-ray direction against the detector is not changed, as discussed above. There is thus no teaching or suggestion of "a second fluoroscopic image data processing section that corrects a ***deformation*** of the fluoroscopic image data," as recited in amended independent Claim 1 in Chiu.

Amended independent Claim 15 is directed to an X-ray diagnosis apparatus for obtaining an X-ray image, including: (1) an X-ray radiator configured to radiate an X-ray to a specimen; (2) a detector configured to detect an X-ray data resulting from the X-ray; (3) a shifter mechanism coupled to the detector and configured to shift the detector along a detecting plane of the detector; (4) an exposer mechanism coupled to the X-ray radiator and configured to cause the X-ray to be exposed throughout an effective detecting area of the detector; (5) a controller configured to control the exposer mechanism in accordance with the shift of the detector; and (6) an image processor coupled to the detector, the image processor

[2] Chiu, column 11, lines 53-61.

having a memory configured to store a past image data and being configured to prepare a fluoroscopic image data based on the detected X-ray data and a reference image data, based on the past image data, of a part of the specimen similar to what is viewed in the fluoroscopic image data in accordance with the shift of the detector.

The Office Action rejects independent Claim 15 on exactly the same basis as independent Claim 1. Specifically, the Office Action asserts at page 2 that Chiu teaches "an angiographic x-ray system for tracking the movement of the catheter tip comprising x-ray source 14, collimator 20, collimator position control 46 (lines 40-47 of column 16), patient support 12, digital imager 3, image chain support and moving means 7 (C-arm, lines 55-63 of column 13), image processor 11/13 with disk storage for determining catheter location and moving the chain in response thereto and display 15." However, Applicant respectfully submits that these teachings do not meet the entirety of the claimed features.

First, Applicant respectfully submits that independent Claim 15 also recites "a shifter mechanism coupled to the detector and configured to shift the detector along a detecting plane of the detector" and that this feature is not taught or suggested by Chiu as discussed above.

Second, Chiu does not teach or suggest "an image processor coupled to the detector, t***he image processor having a memory configured to store a past image data and being configured to prepare a fluoroscopic image data based on the detected X-ray data and a reference image data, based on the past image data, of a part of the specimen similar to what is viewed in the fluoroscopic image data in accordance with the shift of the detector***" since the Chiu's detector is the fixed patient support and is not shifted, as discussed above, so that nothing in Chiu is or could be "in accordance with the shift of the detector."

Therefore, Chiu fails to teach or suggest every feature recited in Applicant's amended independent Claims 1 and 15, so that Claims 1, 3-11, 13-16, 18-25, and 27 are patentably

distinct over Chiu. Accordingly, Applicant respectfully requests reconsideration of the rejection based on Chiu.[3]

In addition, Applicant respectfully submits that the Office Action did not assert that Chiu teaches or suggests "a ***second*** shifter mechanism configured to shift the X-ray radiator to a ***predetermined position***," as recited in amended dependent Claim 5 and, consequently, did not provide a supporting passage in Chiu. It is respectfully submitted that Chiu does not teach or suggest this feature. Further, Applicant notes that amended dependent Claims 6-10, 16, and 21-24 all further define or involve the shift of the detector of independent Claims 1 and 15 absent in Chiu and are thus not anticipated by Chiu.

Applicant respectfully requests reconsideration of the rejection of Claims 12 and 26 under 35 U.S.C. § 103(a) for the reasons set forth below.

Claims 12 and 26 recite "a designation device configured to designate that the detector returns to an initial position." The Office Action asserts at page 2 that "Chiu does not mention means for designating an initial position, but it would have been obvious to provide same since a physician would not start a scan arbitrarily but rather would begin where he knew the catheter was." Applicant respectfully submits in response that even assuming arguendo that this would be obvious, providing "a means for designating an initial position" does not meet "a designating device configured to designate that the detector ***returns*** to an initial position." In other words, the assertion of the Office Action suggests that beginning at a certain location, "where [the physician] knew the catheter was," does not teach or suggest any device for doing something after the process has begun, i.e., not only beginning at a designated location, but ***returning*** to an initial position using a device at some point later in the procedure.

[3] See M.P.E.P. 2131: "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," (Citations omitted) (emphasis added).

Accordingly, Applicant respectfully requests reconsideration of the 35 U.S.C. § 103(a) rejection based on Chiu. Further, if the Examiner maintains the rejection of dependent Claims 12 and 26 based on obviousness, Applicant respectfully requests that a reference be provided in support of the Examiner's contention.

Applicant respectfully requests reconsideration of the rejection of Claims 2 and 17 under 35 U.S.C. § 103(a) for the reasons set forth below.

It is respectfully submitted that Ohishi teaches an X-ray tube 112 and an X-ray detector 113 which rotate together, as illustrated in Figs. 7 and 8. In particular, the detector of Ohishi rotates but clearly does not shift "along a detecting plane of the detector," as recited in amended independent Claims 1 and 15, and illustrated in the non-limiting examples of Figs. 1, 2, 5, 6A, and 6B, since a rotation is not planar, for example. Therefore, Ohishi does not teach or suggest the afore-mentioned features of independent Claims 1 and 15 not taught by Chiu, so that even if the combination of Chiu and Ohishi is assumed to be proper, the combination fails to teach every element of the claimed invention. Accordingly, Applicant respectfully requests reconsideration of the rejection based on Chiu and Ohishi.[4]

Applicant respectfully requests reconsideration of the rejection of Claim 28 under 35 U.S.C. § 103(a) for the reasons set forth below.

Amended independent Claim 28 is directed to an X-ray diagnosis apparatus for obtaining an X-ray image, including: (1) an X-ray radiator configured to radiate an X-ray to a specimen; (2) a detector configured to detect an X-ray data resulting from the X-ray; (3) a set of gears configured to shift the detector along a detecting plane of the detector; (4) an X-ray radiator supporter coupled to the X-ray radiator and configured to move the X-ray radiator so as to cause the X-ray to be exposed throughout an effective detecting area of the detector; (5)

[4] See MPEP 2142 stating, as one of the three "basic criteria [that] must be met" in order to establish a *prima facie* case of obviousness, that "the prior art reference (or references when combined) must teach or suggest all the claim limitations," (emphasis added). See also MPEP 2143.03: "All words in a claim must be considered in judging the patentability of that claim against the prior art."

a controller configured to control the X-ray radiator supporter in accordance with the shift of the detector; (6) an image processor coupled to the detector, the image processor having a memory configured to store one or more past fluoroscopic image data and being configured to prepare a current fluoroscopic image data based on the detected X-ray data and a contrast-enhanced reference image data based on at least one of the past fluoroscopic image data, and further to perform a subtraction processing between, the current fluoroscopic image data and at least a part of the contrast-enhanced reference image data, the part being determined in accordance with the shift of the detector; and (7) a display coupled to the image processor displaying a subtraction processed image.

The Office Action asserts at page 3 that "Chiu does not mention how the C-arm is caused to scan along the patient, but it would have been obvious to employ therefore gear means such as 9 taught by Stein as this is a notorious way of achieving movement."

However, it is respectfully submitted that Chiu does not teach or suggest that "the image processor having a memory configured to store one or more past fluoroscopic image data and being configured to prepare a current fluoroscopic image data based on the detected X-ray data and a contrast-enhanced reference image data based on at least one of the past fluoroscopic image data, and further to perform a subtraction processing between, the current fluoroscopic image data and at least a part of the contrast-enhanced reference image data, the part being determined in accordance with the shift of the detector." Further, Stein's "x-ray source 7, calibration wheel 13, slit collimator 2 and detector array 3 are rigidly connected by mechanical means 8 so that they may be translated in a rigid fashion together by translation mechanism 9."[5] Being "rigidly connected," there is no shift of the detector along a detecting plane of the detector as recited in amended independent Claim 28 and illustrated in the non-limiting examples of Figs. 3B and 6B, for example. That is, neither Chiu nor Stein teaches

[5] Stein, column 5, lines 37-40.

the claimed shift and, in particular, neither Chiu nor Stein teaches "a subtraction processing between, the current fluoroscopic image data and at least a part of the contrast-enhanced reference image data, the part being determined in accordance with the shift of the detector."

Therefore, even if the combination of Chiu and Stein is assumed to be proper, the combination fails to teach every element of the claimed invention. Accordingly, Applicant respectfully requests reconsideration of the rejection based on Chiu and Stein.

Applicant notes that Stein further explains that translation occurs along the patient or, alternatively, and upon re-orienting the slit collimator and the detector array by 90 degrees about the source-detector axis, across the patient.[6] However, in any case, the detector moves solely along one axis.

In order to vary the scope of protection recited in the claims, new Claims 29-34 are added. New Claims 29-32 find non-limiting support in the disclosure as originally filed, for example in Claims 13 and 27; and in Figs. 3A, 3B, 6A, and 6B which show a shift of the detector without a shift of the source. New Claims 33 and 34 find non-limiting support in the disclosure as originally filed, for example in Figs. 7 and 8. Therefore, the changes to the claims are not believed to raise a question of new matter.[7] Further, new Claims 29-34 are believed to be allowable over the cited references.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application, and the present application is believed to be in condition for formal Allowance. A Notice of Allowance for Claims 1-34 is earnestly solicited.

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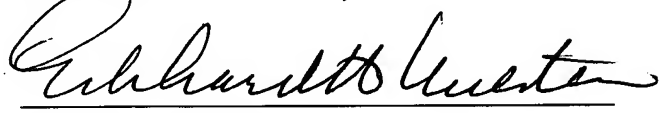
[6] Stein, column 5, lines 41-50.

[7] See M.P.E.P. 2163.06 stating that "information contained in any one of the specification, claims or drawings of the application as filed may be added to any other part of the application without introducing new matter."

Should the Examiner deem that any further action is necessary to place this application in even better form for allowance, the Examiner is encouraged to contact Applicant's undersigned representative at the below listed telephone number.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.



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(ACLM/configured AND EXP/church): 130 patents.
Hits 1 through 50 out of 130

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Refine Search aclm/(configured) and exp/(church)

	PAT. NO.		Title
1	6,925,146	T	X-ray diffraction system
2	6,920,203	T	Method and apparatus for selectively attenuating a radiation source
3	6,917,665	T	X-ray computed tomography apparatus
4	6,907,101	T	CT detector with integrated air gap
5	6,904,120	T	Method and apparatus for correcting bone induced spectral artifacts
6	6,901,129	T	X-ray computer tomography apparatus
7	6,898,265	T	Scintillator arrays for radiation detectors and methods of manufacture
8	6,879,660	T	Method and apparatus for reducing spectrally-sensitive artifacts
9	6,876,720	T	X-ray computed tomography apparatus
10	6,876,719	T	X-ray CT apparatus
11	6,873,683	T	Axial flux motor driven anode target for X-ray tube
12	6,859,522	T	Carotid artery filter system for single view dental panoramic radiographs
13	6,859,514	T	CT detector array with uniform cross-talk
14	6,850,590	T	Mammography cassette holder for patient comfort and methods of use
15	6,848,827	T	Method and apparatus for calibrating detector spectral response
16	6,839,408	T	Two-dimensional, anti-scatter grid and collimator designs, and its motion, fabrication and assembly
17	6,839,407	T	Arrangement of sensor elements
18	6,834,994	T	X-ray imaging apparatus for subtraction angiography
19	6,834,097	T	X-ray CT apparatus and X-ray CT imaging method
20	6,819,740	T	X-ray diagnosis apparatus having a flat panel detector for detecting an X-ray image

21 6,819,739 T Method and apparatus for calibrating an x-ray laminography imaging system
22 6,816,570 T Multi-technique thin film analysis tool
23 6,816,566 T Noncontact type signal transmission device and x-ray computed tomography apparatus including the same
24 6,813,333 T Methods and apparatus for detecting structural, perfusion, and functional abnormalities
25 6,801,596 T Methods and apparatus for void characterization
26 6,801,595 T X-ray fluorescence combined with laser induced photon spectroscopy
27 6,801,594 T Computed tomography fluoroscopy system
28 6,795,529 T High ratio, high efficiency general radiography grid system
29 6,795,525 T Radiation detecting apparatus and radiographing system using it
30 6,785,360 T Personnel inspection system with x-ray line source
31 6,785,359 T Cathode for high emission x-ray tube
32 6,779,920 T X-ray localizer light system
33 6,773,161 T X-ray diagnostic apparatus
34 6,771,735 T Method and apparatus for improved x-ray reflection measurement
35 6,754,302 T X-ray exposure apparatus
36 6,751,293 T Rotary component support system
37 6,751,285 T Dose management system for mammographic tomosynthesis
38 6,742,928 T Dental x-ray block
39 6,741,673 T Mammography device and method utilizing optimally curved support plate configuration for accuracy in imaging and diagnosis
40 6,728,337 T Star pinch plasma source of photons or neutrons
41 6,707,879 T Remote baggage screening system, software and method
42 6,700,948 T Low-cost, multislice CT detector with multiple operating modes
43 6,697,453 T Portable X-ray diffractometer
44 6,693,990 T Low thermal resistance bearing assembly for x-ray device
45 6,687,327 T System and method of medical imaging having task and/or patient size dependent processing
46 6,674,838 T X-ray tube having a unitary vacuum enclosure and housing
47 6,659,642 T Non-circular C-arm for fluoroscopic imaging equipment
48 6,658,082 T Radiation detector, radiation detecting system and X-ray CT apparatus
49 6,621,890 T Method for controlling an ionizing radiation generator and implementing installation
50 6,542,580 T Relocatable X-ray imaging system and method for inspecting vehicles and containers

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segments a and d may be only covered by the penumbra of the X-ray. In this example, it may also be possible to obtain a valid index as the index D by calculation with detections by the detecting segments a and d.

Still further, for example, FIG. **13** is still another example showing a physical relationship between the X-ray tube **101** and the detector **103**, with another aperture width of the slit **121**, according to the first embodiment of the present invention. As shown in FIG. **13**, the detecting segments a and c may be exposed the X-ray and be covered by the umbra in part and also the penumbra in other part, of the X-ray, and the detecting segment b may be exposed the X-ray and be covered by only the umbra of the X-ray. In addition, the detecting segment d may be exposed the X-ray and be covered by only the penumbra of the X-ray. In this example, it may also be possible to obtain a valid index as the index D by calculation with detections by the detecting segments a and d.

The embodiments of the present invention described above are examples described only for making it easier to understand the present invention, and are not described for the limitation of the present invention. Consequently, each component and element disclosed in the embodiments of the present invention may be redesigned or modified to its equivalent within a scope of the present invention. Furthermore, any possible combination of such components and elements may be included in a scope of the present invention as long as an advantage similar to those obtained according to the above disclosure in the embodiments of the present invention is obtained.

What is claimed is:

1. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, comprising a plurality of detecting segments along a slice direction, and configured to detect the X-ray generated by the X-ray generator; and

a controller configured to calculate a gravity point of the plurality of detecting segments based on detection information obtained from the plurality of detecting segments and position information of the plurality of detecting segments relative to a predetermined reference position, to obtain a difference between the calculated gravity point and a theoretical gravity point of the plurality of detecting segments, and to provide the difference as the information of alignment between the X-ray generator and the X-ray detector along the slice direction.

2. The apparatus according to claim **1**, further comprising a display configured to display the information of alignment provided by the controller.

3. The apparatus according to claim **1**, further comprising a communication interface configured to transmit the information of alignment provided by the controller to an external monitoring apparatus.

4. The apparatus according to claim **1**, wherein the alignment between the X-ray generator and the X-ray detector is performed between a central axis of the X-ray generated from the X-ray generator and a center of the detecting segments of the X-ray detector along the slice direction.

5. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, including a plurality of detecting segments along a slice direction, configured to detect the X-ray generated by the X-ray generator;

a controller coupled to the detector and configured to obtain a calculation index based on calculation of a first ratio from penumbra detection information obtained from first and second of the detecting segments when the first and second detecting segments are exposed to the X-ray and at least partially covered by first and second penumbras of the X-ray, respectively, and a second ratio from umbra detection information obtained from the first and second detecting segments when both of the first and second detecting segments are exposed to the X-ray and covered by only an umbra of the X-ray, the first detecting segment opposing the second detecting segment relative to a center of the detecting segments; and

a memory coupled to the controller and configured to store a table including a relation between a table index and shift information for shifting at least one of the X-ray generator and the X-ray detector so as to align the X-ray generator and the X-ray detector,

wherein the controller determines the shift information corresponding to the table index based on the calculation index, and

wherein, when each of the first and second detecting segments comprises a plurality of detecting elements, the penumbra detection information is a bundle of element detection information obtained from the plurality of detecting elements.

6. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, including a plurality of detecting segments alone a slice direction, configured to detect the X-ray generated by the X-ray generator;

a controller coupled to the detector and configured to obtain a calculation index based on calculation of a first ratio from penumbra detection information obtained from first and second of the detecting segments when the first and second detecting segments are exposed to the X-ray and at least partially covered by first and second penumbras of the X-ray, respectively, and a second ratio from umbra detection information obtained from the first and second detecting segments when both of the first and second detecting segments are exposed to the X-ray and covered by only an umbra of the X-ray, the first detecting segment opposing the second detecting segment relative to a center of the detecting segments; and

a memory coupled to the controller and configured to store a table including a relation between a table index and shift information for shifting at least one of the X-ray generator and the X-ray detector so as to align the X-ray generator and the X-ray detector,

wherein the controller determines the shift information corresponding to the table index based on the calculation index, and

wherein the first and second detecting segments are physically situated around the center of the detecting segments.

7. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, including a plurality of detecting segments alone a slice direction, configured to detect the X-ray generated by the X-ray generator;

a controller coupled to the detector and configured to obtain a calculation index based on calculation of a first

ratio from penumbra detection information obtained from first and second of the detecting segments when the first and second detecting segments are exposed to the X-ray and at least partially covered by first and second penumbras of the X-ray, respectively, and a second ratio from umbra detection information obtained from the first and second detecting segments when both of the first and second detecting segments are exposed to the X-ray and covered by only an umbra of the X-ray, the first detecting segment opposing the second detecting segment relative to a center of the detecting segments; and

a memory coupled to the controller and configured to store a table including a relation between a table index and shift information for shifting at least one of the X-ray generator and the X-ray detector so as to align the X-ray generator and the X-ray detector,

wherein the controller determines the shift information corresponding to the table index based on the calculation index, and

wherein the first detecting segment is provided at one end of the detecting segments and the second detecting segment is provided at another end of the detecting segments.

8. A method of providing information of alignment between an X-ray generator and an X-ray detector of an X-ray computed tomography apparatus, wherein the X-ray generator generates an X-ray and the X-ray detector includes a plurality of detecting segments along a slice direction and detects the X-ray generated by the X-ray generator, the method comprising the steps of:

obtaining detection information from the plurality of detecting segments;

calculating a gravity point of the plurality of detecting segments based on the detection information and position information of the plurality of detecting segments relative to a predetermined reference position;

obtaining a difference between the calculated gravity point and a theoretical gravity point of the plurality of detecting segments; and

providing the difference as the information of alignment along the slice direction.

9. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, including a plurality of detecting segments along a slice direction, configured to detect the X-ray generated by the X-ray generator;

a controller coupled to the detector and configured to obtain a calculation index based on calculation of a first ratio from penumbra detection information obtained from first and second of the detecting segments when the first and second detecting segments are exposed to the X-ray and at least partially covered by first and second penumbras of the X-ray, respectively, and a second ratio from umbra detection information obtained from the first and second detecting segments when both of the first and second detecting segments are exposed to the X-ray and covered by only an umbra of the X-ray, the first detecting segment opposing the second detecting segment relative to a center of the detecting segments; and

a memory coupled to the controller and configured to store a table including a relation between a table index and shift information for shifting at least one of the X-ray generator and the X-ray detector so as to align the X-ray generator and the X-ray detector,

wherein the controller determines the shift information corresponding to the table index based on the calculation index, and

wherein the first detecting segment is exposed to the X-ray by the X-ray generator and is covered only by the first penumbra and the second detecting segment is exposed to the X-ray by the X-ray generator and is covered only by the second penumbra for the calculation of the first ratio.

10. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, including a plurality of detecting segments along a slice direction, configured to detect the X-ray generated by the X-ray generator;

a controller coupled to the detector and configured to obtain a calculation index based on calculation of a first ratio from penumbra detection information obtained from first and second of the detecting segments when the first and second detecting segments are exposed to the X-ray and at least partially covered by first and second penumbras of the X-ray, respectively, and a second ratio from umbra detection information obtained from the first and second detecting segments when both of the first and second detecting segments are exposed to the X-ray and covered by only an umbra of the X-ray, the first detecting segment opposing the second detecting segment relative to a center of the detecting segments; and

a memory coupled to the controller and configured to store a table including a relation between a table index and shift information for shifting at least one of the X-ray generator and the X-ray detector so as to align the X-ray generator and the X-ray detector,

wherein the controller determines the shift information corresponding to the table index based on the calculation index, and

wherein the first detecting segment is exposed to the X-ray by the X-ray generator and is covered only by the first penumbra and the second detecting segment is exposed to the X-ray by the X-ray generator and is covered partially by the second penumbra and partially by an umbra of the X-ray for the calculation of the first ratio.

11. An X-ray computed tomography apparatus for providing information of alignment, comprising:

an X-ray generator configured to generate an X-ray;

an X-ray detector, including a plurality of detecting segments alone a slice direction, configured to detect the X-ray generated by the X-ray generator;

a controller coupled to the detector and configured to obtain a calculation index based on calculation of a first ratio from penumbra detection information obtained from first and second of the detecting segments when the first and second detecting segments are exposed to the X-ray and at least partially covered by first and second penumbras of the X-ray, respectively, and a second ratio from umbra detection information obtained from the first and second detecting segments when both of the first and second detecting segments are exposed to the X-ray and covered by only an umbra of the X-ray, the first detecting segment opposing the second detecting segment relative to a center of the detecting segments; and

a memory coupled to the controller and configured to store a table including a relation between a table index and shift information for shifting at least one of the

X-ray generator and the X-ray detector so as to align the X-ray generator and the X-ray detector,

wherein the controller determines the shift information corresponding to the table index based on the calculation index, and

wherein the first detecting segment is exposed to the X-ray by the X-ray generator and is covered partially by the first penumbra and partially by an umbra of the X-ray and the second detecting segment is exposed to the X-ray by the X-ray generator and is covered partially by the second penumbra and partially by the umbra of the X-ray for the calculation of the first ratio.

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